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A further find from the Youndegin meteorite shower

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Abstract

An iron meteorite weighing 4.665 kg has been part of a minerals collection at Quairading District High School for many years, where it is used as an integral resource in a teaching module on meteorites. The cobalt, nickel, gallium and germanium contents of this specimen have been determined by X-ray fluorescence spectrometry. It is identified as a member of chemical group 1A (Wasson 1974). A detailed examination of the microstructure and chemical composition of this specimen with respect to other Youndegin meteorites confirms that it is part of the Youndegin meteorite shower.

Introduction

The first recorded meteorites in Western Australia were a number of irons discovered by Alfred Eaton towards the end of the 19th Century when agriculture was being established to the east of the early settlement at York. These meteorites became known as the "Youndegin" meteorites after a police outpost, located between the present locations of Cunderdin and Quairading. Four iron meteorites were found approximately 1.2 km north-west of Pikaring Rock (Figure 1). These specimens weighed 11.7 kg, 10.9 kg, 7.9 kg and 2.72 kg and are now known as Youndegin I to IV respectively. The meteorites were found on the surface within a few metres of each other. Weathering products of the meteorites were also found in the immediate vicinity, suggesting that the specimens were part of a single shattered or disintegrated mass which had resided on the earth's surface for a considerable period of time.

In 1891 a much larger specimen, 173.5 kg in weight, was discovered to the south-east of Pikaring Rock, and in 1892 yet another large specimen weighing 927 kg was discovered. These two meteorites were named Youndegin V and VI respectively.

However some meteorites found in the same district were not given the name "Youndegin". In 1892 two iron meteorites were found to the east of Pikaring Rock. These weighed 92.3 kg and 0.68 kg and were given the name "Mount Stirling". Other meteoritic fragments named Mooranoppin were subsequently found to the north of Pikaring Rock, although the exact location is uncertain. The largest meteorite in the district was found in 1903 in the Wamenusking area south-east of Quairading. Its existence was not officially known until 1952 when Mrs W. Sharett sent a picture of the meteorite to the "West Australian" newspaper. It was subsequently donated to the Western Australian Museum by Mr E. C. Johnson in 1954. This 2 626 kg meteorite was given the name "Quairading".

Youndegin VII, a 4.1 kg iron meteorite, was found in 1929 approximately 8 km north-east of Pikaring Rock. Other fragments from this area, weighing a total of 13.6 kg, have been found from time to time in the same vicinity, and are collectively known as Youndegin VIII.

Simpson (1938) suggested that the Mooranoppin and Mount Stirling meteorites were part of the Youndegin meteorite shower. He also described Youndegin VII and VIII, and pointed out that one of the pieces of Youndegin VIII was made into a horseshoe by a blacksmith in York. McCall and De Laeter (1965) provided details of all the meteorites listed above. They pointed out that Quairading was in all probablity part of the Youndegin meteorite shower. McCall (1972) reports that there is a small sample of iron shale, collected prior to the removal of the Quairading meteorite to the W.A. Museum, in the collection at the Western Australian School of Mines.

De Laeter (1973) made a detailed examination of the geographical location, microstructure and chemical composition of the Mount Stirling, Mooranoppin and Quairading meteorites and compared them with samples of Youndegin I-VII. In particular the cobalt, nickel, gallium and germanium contents of these ten meteorites were determined by X-ray fluorescence spectrometry. The similarity in the chemical data enabled all ten meteorites to be classified as members of chemical Group 1A (Wasson 1974). De Laeter (1973) concluded that the specimens were all part of the Youndegin meteorite shower which probably resulted from a meteoroid travelling in a south westerly direction. Table 1 gives details of the various meteorites found in the Quairading district, their masses, date of find and the present location of the main mass of each specimen.

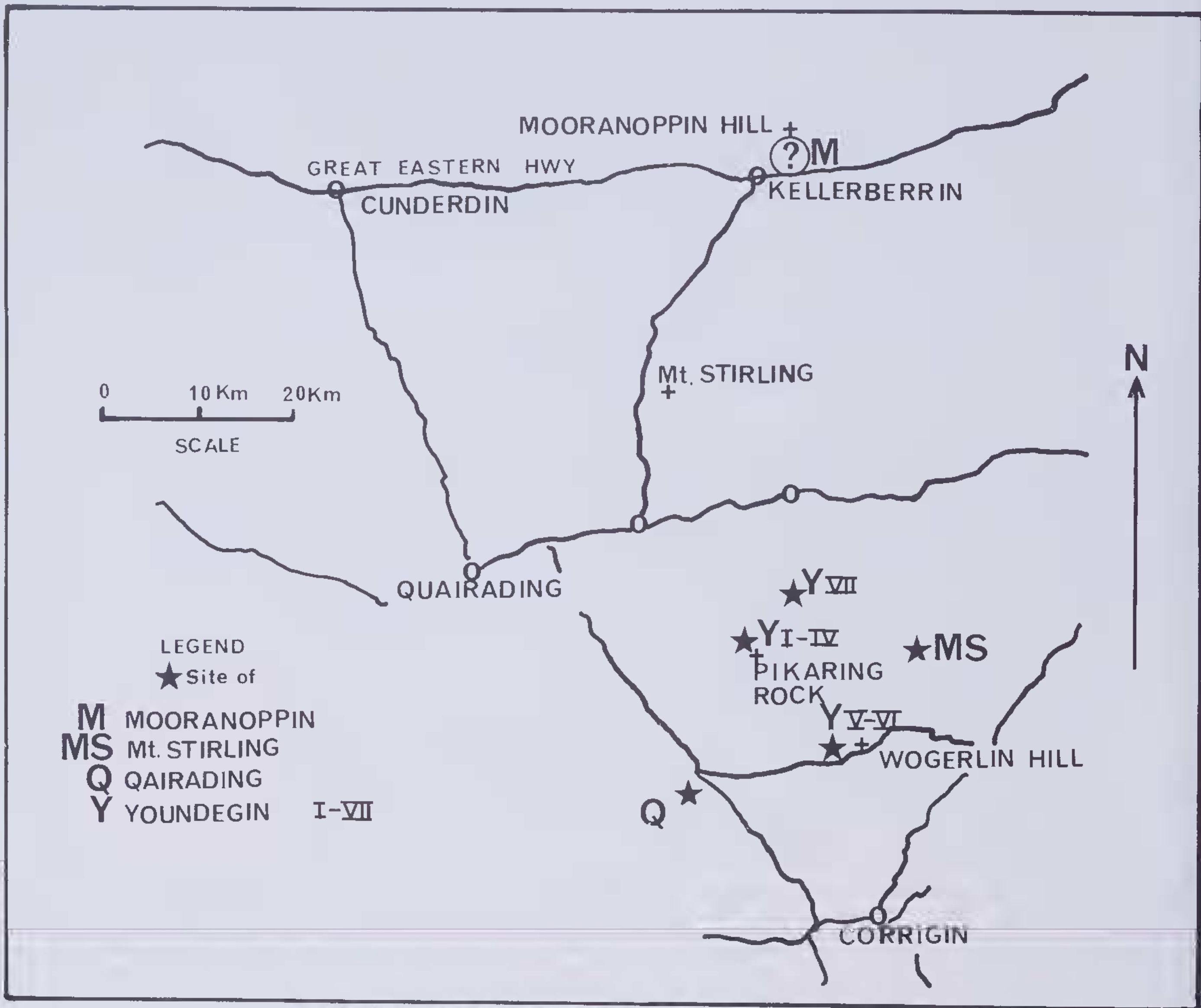

Figure 1.—Location of the specimens comprising the Youndegin meteorite shower.

Table 1

Details of the Youndegin meteorites

Name	Main mass	Date of find	Location of main mass
Youndegin I	11.7 kg	1884	British Museum, London: 9.82 kg
Youndegin II	10.9 kg	1884	National Museum, Melbourne: 10.9 kg
Youndegin III	7.9 kg	1884	Western Australian Museum: 5 kg
Youndegin IV	2.72 kg	1884	British Museum, London: 2.7 kg
Youndegin V	173.5 kg	1891	Field Museum, Chicago: 141 kg
Youndegin VI	927 kg	1892	Naturhistorisches Museum, Vienna: 927 kg
Youndegin VII	4.1 kg	1929	Western Australian Museum: 3.9 kg
Youndegin VIII....	13.6 kg	1891-1929	Private Collections
Mooranoppin.......	1.6 kg	1893	Ward-Coonley Collection: 1.1 kg
	0.820 kg		Western Australian Museum 0.725 kg
Mount Stirling......	92.3 kg	1892	Australian Museum, Sydney: 67.2 kg
	0.680 kg		
Quairading...........	2 626 kg	1903	Western Australian Museum: 2 626 kg

Description of the new find

Quairading District High School (previously Quairading Junior High School), has had a number of meteorites donated to it by farmers and students in the district. Most of these specimens were small fragments about the size of a 20 cent piece, and none now remain in the School. However two large samples were retained by the School's Science Department. The meteoritic fragments were donated to the School prior to 1972.

Mr K. Ireland, a science teacher at Quairading District High School, has produced a teaching module on meteorites to capitalize on the unusual situation of a school being in possession of meteorite specimens, and located in an area in which many meteorites have been discovered. The module is part of an astronomy topic, which is itself a sub-set of a science course taken by all secondary school students in Western Australia.

The School was prepared to allow the two specimens to be examined at the Western Australian Institute of Technology. The two specimens weighed 1.130 kg and 4.665 kg respectively. However when the specific gravity of the specimens were measured, values of 4.19g cm^{-3}

and 7.40g cm^{-3} were obtained respectively. It was therefore obvious that the smaller sample was not an iron meteorite. In all probability it is a piece of iron ore.

Two photographs of the larger specimen are shown in Figure 2. The meteorite is approximately 16 cm long, by 14 cm wide, by 8 cm high. A polished and etched surface of the new find is shown in Figure 3. The Widmanstatten pattern may be compared to Figures 2 and 3 in De Laeter (1973). The etched surface is very similar to these other samples of the Youndegin meteorites. The meteorite can therefore be classified as a coarse (Og) or coarsest (Ogg) octahedrite, (Buchwald 1975). The main constituent is the nickel-iron alloy kamacite, arranged in regular, well-defined plates, parallel to the faces of a regular octahedron. The apparent thickness of the plates varies from 1 to 5 mm. The specimen exhibits the richness of inclusions described by Simpson (1938) and Buchwald (1975).

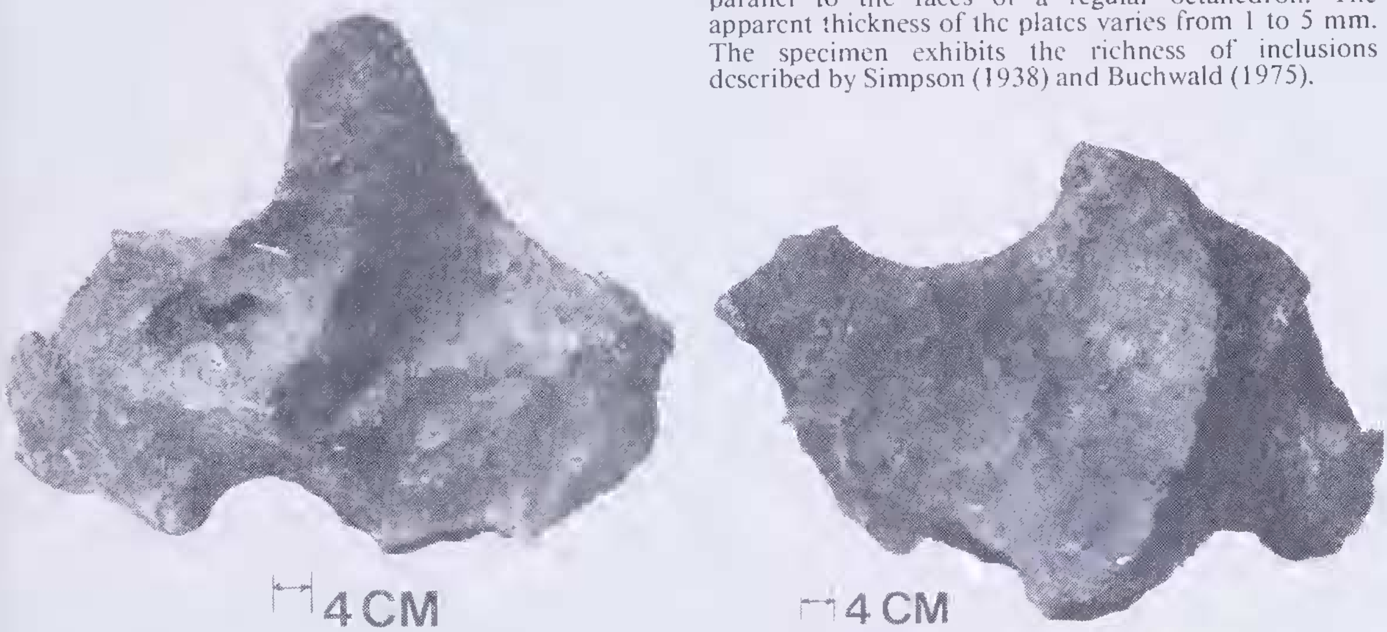

Figure 2.—The 4.665 kg iron meteorite from the Quairading District High School.

Figure 3.—A polished and etched section of the new specimen of the Youndegin meteorite shower.

Table 2
Analytical Data for the Youndegin meteorite shower

Meteorite	Nickel (%)	Cobalt (%)	Gallium (ppm)	Germanium (ppm)	Reference
Quairading High School Specimen	7.08 ± 0.04	0.45 ± 0.01	90 ± 3	342 ± 8	This work
Mount Stirling	6.79 ± 0.04	0.44 ± 0.01	84 ± 3	340 ± 8	This work
	6.81 ± 0.04	0.44 ± 0.01	87 ± 3	360 ± 8	De Laeter (1973)
Quairading	6.85 ± 0.04	0.45 ± 0.01	90 ± 3	346 ± 8	This work
	6.83 ± 0.04	0.44 ± 0.01	90 ± 3	359 ± 8	De Laeter (1973)
Youndegin III	6.81 ± 0.04	0.45 ± 0.01	90 ± 3	348 ± 8	This work
	6.83 ± 0.04	0.46 ± 0.01	90 ± 3	346 ± 8	De Laeter (1973)

The first detailed examination of the Youndegin meteorites was made by Fletcher (1887) who described the presence of schreibersite and a cubic form of graphitic carbon which he named cliftonite. Buchwald (1975) has described the microstructure of the Youndegin meteorites in detail. In addition to schreibersite, Buchwald points out that troilite occurs as scattered inclusions, often intergrown with significant amounts of graphite. Cohenite is also common, and often forms rims around the schreibersite inclusions.

Chemical composition

Table 2 gives the nickel, cobalt, gallium and germanium concentrations determined by X-ray fluorescence spectrometry on flat, polished pieces of a number of specimens of the Youndegin meteorite shower, using the technique described by Thomas and De Laeter (1972). The previous determinations of the four elements by De Laeter (1973) are also listed in Table 2. The errors quoted with the values are based on counting statistics and are at the 95% confidence level.

The correlation between the values for cobalt, gallium and germanium for the new specimen and for Mount Stirling, Quairading and Youndegin III is extremely good. The nickel value of 7.08 ± 0.04% for the new specimen is higher than for the other three samples analysed in this study. De Laeter (1973) analysed 10 samples of the Youndegin meteorite shower and obtained a range of nickel values from 6.47% to 6.92%. The sampling problem with coarse octahedrites can be quite difficult. Wasson (1970) obtained a nickel value of 6.38% for a Youndegin sample, whilst a value of 7.4% was obtained for Mount Stirling (Wasson 1974). Buchwald (1975) suggested that the low value obtained by Wasson (1970) could have been measured on a specimen in which the kamacite was more abundant than for the bulk meteorite. Conversely, high nickel values may result from specimens with more abundant taenite than in the bulk meteorite. One of the disadvantages of X-ray fluorescence spectrometry is that the measured concentrations are only representative of a thin surface layer of the specimen.

Wasson (1974) defines chemical group 1A as those iron meteorites with 190 to 520 ppm germanium which fall within main sequence fields on germanium-gallium and germanium-nickel plots, with nickel and gallium values in the range 6.4% to 8.7% and 55 ppm to 100 ppm respectively. The analytical data listed in Table 2 confirm that the new specimen is a member of chemical group 1A.

Thus the chemical composition and microstructure of the new specimen from the Quairading District High School confirms that it is a fragment of the Youndegin meteorite shower. Youndegin is an impressive shower comprising numerous fragments ranging up to 2 626 kg in weight. The approximate extent of the shower as shown in Figure 1 covers an approximate area of 25 x 15 km (discounting Mooranoppin whose location is uncertain), with most of the samples being found in the vicinity of Pikaring Rock. It is unfortunate that no firm details are available as to the location of this new specimen of the Youndegin meteorite shower since it is the first new specimen to be reported for approximately 50 years. However one cannot rule out the possibility that other specimens are in existence, and perhaps some of these may be located in the future.

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